Grundfos CIU 200

Modbus RTU for Grundfos Hydro MPC, Control MPC and Multi-E

GB Functional profile and user manual

Original installation and operating instructions.

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1. Symbols used in this document

Caution ***If these safety instructions are not observed, it may result in malfunction or damage to the equipment!***

Note ***Notes or instructions that make the job easier and ensure safe operation.***

2. Introduction

2.1 About this functional profile

This functional profile describes the CIU 200 (Modbus Communication Interface Unit 200) for the following products:

- Grundfos Hydro MPC/Control MPC (CU 351)
- Grundfos Hydro Multi-E.

In the following, the CIU 200 is referred to as "communication interface", and the Hydro MPC, Control MPC and Hydro Multi-E are referred to as "controller".

The data in this document are subject to change without prior notice. Grundfos cannot be held responsible for any problems caused directly or indirectly by using information in this functional profile.

2.2 Assumptions

This functional profile assumes that the reader is familiar with commissioning and programming Modbus devices. The reader should also have some basic knowledge of the Modbus protocol and technical specifications.

It is also assumed that an existing Modbus RTU network with a Modbus master is present.

2.3 Definitions and abbreviations

CIM 200	Communication Interface Module (built into the CIU 200)
CIU 200	Communication Interface Unit
CRC	Cyclic Redundancy Check, a data error detection method
Derivation cable	Stub cable
GENIbus	Proprietary Grundfos fieldbus standard
H	Pressure (Head)
Hydro MPC	Grundfos Hydro Multi-Pump Controller
LED	Light-Emitting Diode
Modbus	A serial communications protocol commonly used in industry and building services
Q	Flow
RTU	Remote Terminal Unit
Transmission speed	Bits transferred per second
Trunk cable	Main RS-485 cable on Modbus network

2.4 System diagram

The system diagram gives an overview of how to connect the CIU 200 to the Grundfos Hydro MPC or Hydro Multi-E that is to be connected to a Modbus network.

The Hydro MPC or Hydro Multi-E controls and monitors a number of pumps (1-6), all connected with RS-485 cables. If fitted with an extra GENIbus module, the Hydro MPC can be connected to the CIU 200 via a RS-485 cable.

The CIU 200 solution is a box with a power supply module and a CIM 200 Modbus module. It can either be mounted on a DIN rail or on a wall. The enclosure class is IP54.

Grundfos Hydro MPC connected to CIU 200

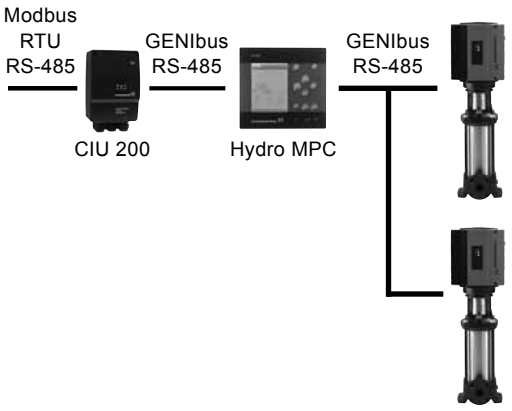

Fig. 1 CIU 200 solution for Hydro MPC

Grundfos Hydro Multi-E connected to CIU 200

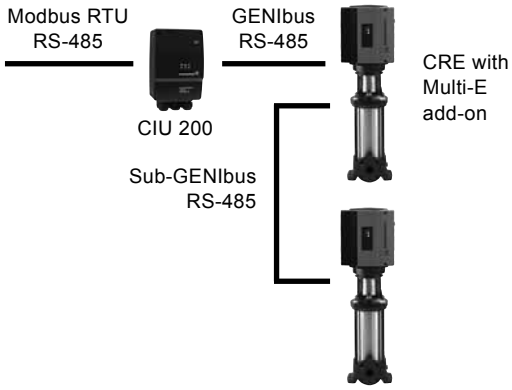

Fig. 2 CIU 200 solution for Hydro Multi-E

2.5 Specifications

The table below gives an overview of the specifications for the Grundfos CIU 200. For further details, please refer to the specific sections of this functional profile.

General data		
Ambient humidity	30 % to 95 %	Relative, non-condensing
GENIbus visual diagnostics	LED2	Off, constantly green, flashing red, constantly red. See section *3.8 LEDs*.
Communication interface unit (CIU 200)		
Power supply	24-240 V	Located in the CIU 200.
GENIbus connection type	RS-485	
GENIbus wire configuration	Three-wire + screen	Conductors: A, B and Y.
Modbus specifications		
Data protocol	Modbus RTU	
Modbus connector	Screw-type terminal	3 pins. See section *3.2 CIM 200 Modbus module*.
Modbus connection type	RS-485	
Modbus wire configuration	Two-wire + common	Conductors: D0, D1 and Common. See section *3.2 CIM 200 Modbus module*.
Communication transceiver	Integrated in the product	Connect either via passive TAP or daisy chain.
Maximum trunk cable length	1200 m	Equals 4000 ft.
Maximum derivation cable length	250 m (at 38400 bits/s)	Equals 820 ft.
Slave address	1-247	Set via rotary switches SW6 and SW7. See section *3.6 Modbus address selection*.
Line termination	On or Off	Set via DIP switches SW1 and SW2. See section *3.7 Termination resistor*.
Supported transmission speeds	1200*, 2400*, 4800*, 9600, 19200, 38400 bits/s	Set via DIP switches SW4 and SW5. See section *3.4 Setting the Modbus transmission speed*. (*Can only be set via software).
Start bit	1	Fixed value.
Data bits	8	Fixed value.
Stop bits	1 or 2	Set via DIP switch SW3. See section *3.5 Setting the parity*.
Parity bit	Even parity or no parity	Set via DIP switch SW3. See section *3.5 Setting the parity*.
Modbus visual diagnostics	LED1	Off, flashing green, flashing red, constantly red. See section *3.8 LEDs*.
Maximum number of Modbus devices	32	Using repeaters, this number can be increased. Address range is 1-247.
Maximum Modbus telegram size	253 bytes	256 - server address (1) - CRC (2) = 253 bytes.

3. Modbus interface

3.1 Modbus bus topology

The Grundfos CIU 200 is connected as a Modbus slave directly to the Modbus RTU network. This is done either in daisy chain style, or using a passive TAP and a derivation cable (stub).
Both methods are exemplified below.

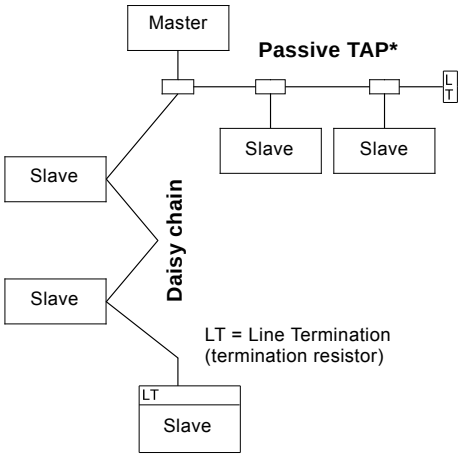

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Fig. 3 Example of Modbus network with termination

In such a network, only one master device is connected to the serial bus, and one or several (maximum 247) slaves are also connected to the serial bus. Slaves cannot communicate with each other and will never transmit data without receiving a request from the master device.

Up to 32 devices can be connected to one RS-485 Modbus system without using a repeater. To implement a larger number of devices, use a repeater to connect the smaller networks to larger networks. Repeaters are also used to extend the maximum transmission distance.

3.2 CIM 200 Modbus module

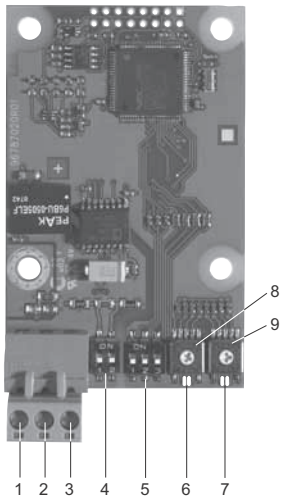

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Fig. 4 CIM 200 Modbus module

Pos.	Designation	Description
1	D1	Modbus terminal D1 (positive data signal)
2	D0	Modbus terminal D0 (negative data signal)
3	Common/GND	Modbus terminal Common/GND
4	SW1/SW2	On/off switches for termination resistor
5	SW3/SW4/SW5	Switches for selection of Modbus parity and transmission speed
6	LED1	Red/green status LED for Modbus communication
7	LED2	Red/green status LED for internal communication between the CIM 200 and Hydro MPC / Hydro Multi-E
8	SW6	Hex switch for setting the Modbus address (four most significant bits)
9	SW7	Hex switch for setting the Modbus address (four least significant bits)

3.3 Connecting the Modbus

A screened, twisted-pair cable must be used. The cable screen must be connected to protective earth at both ends.

Recommended connection

Modbus terminal	Colour code	Data signal
D1-TXD1	Yellow	Positive
D0-TXD0	Brown	Negative
Common/GND	Grey	Common/GND

3.4 Setting the Modbus transmission speed

The transmission speed must be set correctly before the CIM 200 Modbus module is ready to communicate with the Modbus network. DIP switches SW4 and SW5 are used for setting the transmission speed. See fig. 5.

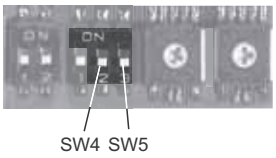

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Fig. 5 Modbus transmission speed

DIP switch settings

Available transmission speeds in bits/s: 1200, 2400, 4800, 9600, 19200 and 38400.

The first three transmission speeds are only available via software settings, whereas the last three are available via DIP switches.

Transmission speed [bits/s]	SW4	SW5
9600	OFF	ON
19200	OFF	OFF
38400	ON	OFF
Software-defined	ON	ON

Default transmission speed is 19200 bits per second, as per the Modbus RTU standard.

The transmission speed will be effective immediately after setting the values of the DIP switch.

Software-defined

When SW4 and SW5 are set to "software-defined", writing a value to the holding register at address 00004 will set a new transmission speed.

Use the following values for software-defined transmission speeds:

Software-defined transmission speed	Set register value 00004
1200 bits/s	0
2400 bits/s	1
4800 bits/s	2
9600 bits/s	3
19200 bits/s	4
38400 bits/s	5

This value is set to 1200 bits/s as default.

The communication interface does not support transmission speeds above 38400 bits/s.

The software-defined transmission speed value will be stored in the communication interface and will remain after a power-off.

Note ***When software-defined transmission speed is enabled (ON), software-defined parity and stop bit are also enabled.***

3.5 Setting the parity

The parity can be set either manually by using SW3 or via software-defined settings.

Manual setting of parity

The CIM 200 only supports the Modbus RTU mode and hence cannot communicate with Modbus ASCII mode devices.

Default byte format (11 bits):

- 1 start bit
- 8 data bits (least significant bit sent first)
- 1 parity bit (even parity)
- 1 stop bit.

The default setting of the CIM 200 Modbus module is even parity (1 stop bit). It is possible to change the parity with DIP switch SW3. The parity can be changed to no parity (2 stop bits). See fig. 6.

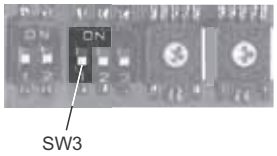

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Fig. 6 Parity

DIP switch settings

Parity	SW3
Even parity, 1 stop bit	OFF
No parity, 2 stop bits	ON

Software-defined parity and stop bit

When SW4 and SW5 are set to "software-defined", the value in holding registers at addresses 00009 and 00010 will override the setting of SW3. See figs 5 and 6.

Software-defined parity	Set register value 00009
No parity [default]	0
Even parity	1
Odd parity	2

Software-defined stop bit	Set register value 00010
1 stop bit [default]	1
2 stop bits	2

The software-defined parity and stop bit values will be stored in the communication interface and will remain after a power-off.

Note ***Before the parity and stop bit can be set via software-defined settings, SW4 and SW5 must be set to ON.***

3.6 Modbus address selection

A Modbus slave on a Modbus network must have a unique address from 1-247. Address 0 is reserved for broadcasting, and is not a valid slave address.

To set the Modbus address, two hexadecimal rotary switches (SW6 and SW7) are used. See fig. 7.

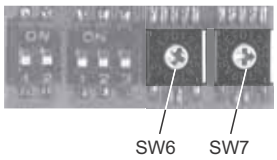

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Fig. 7 Setting the Modbus address

For a complete overview of Modbus addresses, see section *10. Modbus address* on page 27.

Note ***The Modbus address must be set decimally from 1 to 247.***

3.7 Termination resistor

The termination resistor is fitted on the CIM 200 Modbus module and has a value of 150 Ω.

The CIM 200 has a DIP switch with two switches (SW1 and SW2) for cutting the termination resistor in and out. Figure 8 shows the DIP switches in cut-out state.

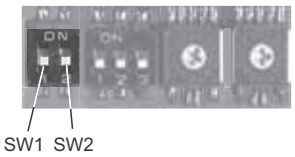

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Fig. 8 Cutting the termination resistor in and out

DIP switch settings

Status	SW1	SW2
Cut-in	ON	ON
Cut-out	OFF	OFF
	ON	OFF
	OFF	ON

Default setting: Termination resistor cut-out.

Cable length

The trunk cable must not exceed a total length of 1,200 m (4,000 ft).

Grundfos recommends the following maximum lengths:

bits/s	Maximum cable length	
	Terminated cable	Unterminated cable
	[m/ft]	[m/ft]
1200-9600	1200/4000	1200/4000
19200	1200/4000	500/1700
38400	1200/4000	250/800

Note ***To ensure a stable and reliable communication, it is important that only the termination resistor of the first and last units in the Modbus network are cut in. See fig. 3.***

3.8 LEDs

The CIM/CIU 200 Modbus module has two LEDs.

See fig. 4.

- Red/green status LED (LED1) for Modbus communication between master and slave
- Red/green status LED (LED2) for internal communication between the CIM 200 and Hydro MPC / Hydro Multi-E.

3.8.1 LED1, Modbus communication

Status	Description
Off	No Modbus communication.
Flashing green	Modbus communication active.
Flashing red	Fault in the Modbus communication.
Constantly red	Fault in the CIM 200 Modbus configuration.

3.8.2 LED2, internal communication

Status	Description
Off	The CIM/CIU 200 has been switched off.
Flashing red	No internal communication between the CIM/CIU 200 and Hydro MPC / Hydro Multi-E.
Constantly red	The CIM/CIU 200 does not support the Hydro MPC / Hydro Multi-E connected.
Constantly green	Internal communication between the CIM/CIU 200 and Hydro MPC / Hydro Multi-E is OK.

Note ***During start-up, there may be a delay of up to 5 seconds before the LED2 status is updated.***

Note ***Before the LED2 can be used for status, the Hydro MPC / Hydro Multi-E controller must be fully booted.***

4. Functional profile

4.1 Register block overview

The Modbus RTU registers are grouped in the following register blocks:

Start address	Register block	Permissions	Description
00001	CIM configuration	R/W	Configuration of the CIM module.
00021	CIM status	R	Status registers for the CIM module.
00101	Control	R/W	Registers for control of the Hydro MPC / Hydro Multi-E.
00201	Status	R	Registers for reading mode status from the Hydro MPC / Hydro Multi-E.
00301	Data	R	Registers for reading measured data values from Hydro MPC / Hydro Multi-E.
00401	Subpump 1	R	Registers for subpump 1 data and status.
00411	Subpump 2	R	Registers for subpump 2 data and status.
00421	Subpump 3	R	Registers for subpump 3 data and status.
00431	Subpump 4	R	Registers for subpump 4 data and status.
00441	Subpump 5	R	Registers for subpump 5 data and status.
00451	Subpump 6	R	Registers for subpump 6 data and status.

All addresses contain registers. Some are bit-interpreted while others are 16-bit values, or part of 32-bit values.

4.2 CIM configuration register block

Registers in this block can be read by means of function codes 0x03 and/or 0x04. They can be written as holding registers with function codes 0x06 and 0x10.

Address	Register name	Description
00001	SlaveMinimumReplyDelay	The minimum reply delay from the slave in ms. Value range: 0-10000, i.e. up to 10 seconds reply delay. This delay is typically used in conjunction with a modem. The delay value is stored in the device and will remain after a power-off. The delay set here will be added to the internal delay in the device. Default value is 0.
00002	RegisterOffset	An address offset that is added to all addresses above 00100. Default value is 0. **Note:** This offset does not affect the CIM configuration register block or the CIM status register block addresses. The register offset value is stored in the device and will remain after a power-off. For most applications, this offset should not be changed.
00003	SoftwareDefinedModbusAddress	If the Modbus address switch has not been set correctly, i.e. not within the 1 to 247 range, the value in this register is used as Modbus address. See section *3.6 Modbus address selection*. The value is stored in the device and will remain after a power-off.
00004	SoftwareDefinedBitRate	Modbus software-defined transmission speed enumeration. The software-defined transmission speed value is stored in the device and will remain after a power-off. 0 = 1200 bits/s 1 = 2400 bits/s 2 = 4800 bits/s 3 = 9600 bits/s 4 = 19200 bits/s 5 = 38400 bits/s. **Note:** This value is used only when the transmission speed is set to "Software-defined" on the DIP switches SW4 and SW5. Otherwise, it will be ignored by the slave.
00005	AutoAckControlBits	Used to select the behaviour of control bit acknowledgements from the CIU 200. 0 = Disabled. Control bits are not automatically lowered when accepted by the device. The user must lower the triggered control bit manually before the control bit can be triggered again. 1 = Enabled. Control bits are automatically lowered when accepted by the device. The user does not have to lower it manually [default].
00006	RESERVED	-
00007	RESERVED	-
00008	RESERVED	-
00009	SoftwareDefinedParity	Parity setting to be used when using "software-defined" settings. 0 = No parity [default] 1 = Even parity 2 = Odd parity.
00010	SoftwareDefinedStopBit	Stop bit setting to be used when using "software-defined" settings. 0 = No stop bit 1 = 1 stop bit [default] 2 = 2 stop bits.

4.3 CIM status register block

Registers in this block can be read by means of function codes 0x03 and/or 0x04. They are read-only. This block can be used for various kinds of fault finding.

Address	Register name	Description
00021	GENIbusCRCErrorCnt	Holds a CRC error counter for the GENIbus connection to the Hydro MPC / Hydro Multi-E.
00022	GENIbusDataErrorCnt	Holds a data error counter for the GENIbus connection to the Hydro MPC / Hydro Multi-E.
00023	VersionNumber	A Grundfos-specific version number. This is an unsigned integer value.
00024	ActualModbusAddress	Holds the current Modbus slave address of the device. Valid value range: 1…247.
00025 00026	GENIbusTXcountHI GENIbusTXcountLO	Holds a transmit counter for total number of telegrams sent to the Hydro MPC / Hydro Multi-E on the GENIbus connection.
00027 00028	GENIbusRXcountHI GENIbusRXcountLO	Holds a receive counter for total number of telegrams received from the Hydro MPC / Hydro Multi-E on the GENIbus connection.
00029	RESERVED	-
00030	UnitFamily	Grundfos product family.
00031	UnitType	Grundfos product type.
00032	UnitVersion	Grundfos product version.

4.4 Control register block

Registers in this block can be read by means of function codes 0x03 and/or 0x04. They can be written as holding registers with function codes 0x06 and 0x10.

Address	Register name	Description
00101	Bit 0: RemoteAccessReq	Control bit that sets local or remote control. 0 = Local 1 = Remote (controlled by Modbus master). This bit must be set to 1 if the Hydro MPC / Hydro Multi-E is to be controlled by a Modbus master. For Hydro MPC, it is also necessary to enable bus control via the CU 351 operator display (Settings/Secondary functions/Control source and select "From bus"). If the RemoteAccessReq bit is set to logical 0, the Hydro MPC will operate with local mode settings as selected on the CU 351 operator display. If local control is desired, select this from the CU 351 operator display (Settings/Secondary functions/Control source and select "From the CU 351"), and set the RemoteAccessReq bit to 0.
	Bit 1: OnOffReq	Control bit that switches the Hydro MPC / Hydro Multi-E to on or off. 0 = Off (stop) 1 = On (start).
	Bit 2: ResetAlarm	Control bit that resets alarms and warnings from the Hydro MPC / Hydro Multi-E. 0 = No resetting 1 = Resetting alarm. This control bit is triggered on rising edge only, i.e. setting logical 0 to 1. See section *4.2 CIM configuration register block*, address 00005, for acknowledgement behaviour.
	Bits 3-15: RESERVED	-
00102	ControlMode	Sets the control mode enumeration. 0 = CONST_SPEED (constant speed) 1 = CONST_FREQ (constant frequency) 3 = CONST_HEAD (constant head) 4 = CONST_PRESSURE (constant pressure) 5 = CONST_DIFFPRESS (constant differential pressure) 6 = VAR_DIFFPRESS (variable differential pressure) 7 = CONST_FLOW (constant flow) 8 = CONST_TEMP (constant temperature) 10 = CONST_LEV (constant level). See section *5.1 Control modes*. **Note:** The control mode depends on the primary sensor.
00103	OperationMode	A state enumeration to control the Hydro MPC / Hydro Multi-E operating mode. 0 = Auto-control (setpoint control according to selected control mode) 4 = OpenLoopMin (running at minimum speed) 6 = OpenLoopMax (running at maximum speed). **Note:** "OnOffReq" has higher priority than the OperationMode, meaning that "OnOffReq" must be set to on, for the OperationMode to have any effect.
00104	Setpoint	Sets the Hydro MPC / Hydro Multi-E setpoint. The scale is 0.01 %, so the value must be from 0 to 10000 to represent the entire 0 % - 100 % range. **Closed loop** Percentage of closed-loop feedback sensor range. **Open loop** Percentage of total system performance. **Common examples** 4700 = 47 % 8000 = 80 %. See section *5.2 Setpoint*.

4.5 Status register block

Registers in this register block can be read by means of function codes 0x03 and/or 0x04. They are read-only.

Address	Register name	Description
00201	Bits 0-2: RESERVED	-
	Bit 3: ResetAlarmAck	Indicates if a ResetAlarm command was acknowledged by the device. This bit will be set when the CIU 200 has accepted a ResetAlarm command, and the programmer can clear the ResetAlarm bit. The ResetAlarmAck bit will automatically be cleared to 0 by the CIU 200 when the ResetAlarm bit is cleared by the master device, and a new ResetAlarm command can be attempted by raising ResetAlarm bit again. 0 = No acknowledgement 1 = Command acknowledged. This functionality is only used when AutoAcknowledgeEvents is disabled. See section *4.2 CIM configuration register block*.
	Bits 4-5: RESERVED	-
	Bit 6: Rotation	Indicates if any subpumps are rotating (running) or not. 0 = No rotation 1 = Rotation.
	Bit 7: RESERVED	-
	Bit 8: AccessMode	Indicates if the Hydro MPC / Hydro Multi-E is locally or remotely controlled. 0 = Local (a local control source with higher priority controls the system) 1 = Remote (controlled by Modbus master).
	Bit 9: OnOff	Indicates if the Hydro MPC / Hydro Multi-E is on or off. 0 = Off (stopped, the green LED on the controller flashes) 1 = On (started, the green LED on the controller is on). Started does not necessarily indicate rotation, for instance in case of low-flow stop.
	Bit 10: Fault	Indicates if there is a fault or not. 0 = No fault 1 = Fault (red LED on the controller is on).
	Bit 11: Warning	Indicates if there is a warning or not. 0 = No warning 1 = Warning (red LED on the controller is on). The system will continue running even if there is a warning.
	Bit 12: RESERVED	-
	Bit 13: AtMaxSpeed	Indicates if the system is running at maximum speed. 0 = No 1 = Yes.
	Bit 14: RESERVED	-
	Bit 15: AtMinSpeed	Indicates if the system is running at minimum speed. 0 = No 1 = Yes.
00202	ProcessFeedback	Indicates the actual process feedback from the controller. The scale is 0.01 %, so the valid value range is from 0 to 10000. This value can be compared with the setpoint value. **Closed loop** Percentage of closed-loop feedback sensor range. **Open loop** Percentage of total system performance. **Common examples** 4700 = 47 % 8000 = 80 %.
00203	ControlMode	Indicates the actual control mode. 0 = CONST_SPEED (constant speed) 1 = CONST_FREQ (constant frequency) 3 = CONST_HEAD (constant head) 4 = CONST_PRESSURE (constant pressure) 5 = CONST_DIFFPRESS (constant differential pressure) 6 = VAR_DIFFPRESS (variable differential pressure) 7 = CONST_FLOW (constant flow) 8 = CONST_TEMP (constant temperature) 10 = CONST_LEV (constant level).
00204	OperationMode	Indicates the actual operating mode. 0 = Auto-control (setpoint control according to selected control mode) 4 = OpenLoopMin (running at minimum speed) 6 = OpenLoopMax (running at maximum speed).
00205	AlarmCode	The Grundfos-specific alarm code. See section *9. Grundfos alarm and warning codes*.
00206	WarningCode	The Grundfos-specific warning code. See section *9. Grundfos alarm and warning codes*.
00207	RESERVED	-

Address	Register name	Description
00208	SubPumpsPresent	Indicates presence of subpumps. This value is bit-interpreted: Bit 0: Pump 1, Bit 1: Pump 2, etc. A bit value of "1" indicates that the subpump is present.
00209	SubPumpsRunning	Indicates the running status of subpumps. This value is bit-interpreted: Bit 0: Pump 1, Bit 1: Pump 2, etc. A bit value of "1" indicates that the subpump is running.
00210	SubPumpsFault	Indicates alarm status of subpumps. This value is bit-interpreted: Bit 0: Pump 1, Bit 1: Pump 2, etc. A bit value of "1" indicates that the subpump has an alarm.
00211	SubPumpsCommFault	Indicates communication status of subpumps. This value is bit-interpreted: Bit 0: Pump 1, Bit 1: Pump 2, etc. A bit value of "1" indicates that the subpump has a communication error.
00212	SystemActiveFunctions	Indicates active system functions (only available on Hydro MPC): Bit 0 = - Bit 1 = Emergency Run function active Bit 2 = Standby pumps active Bit 3 = Pump test run active Bit 4 = Alternative setpoint active Bit 5 = Clock program active Bit 6 = Remote VNC (Virtual Network Connection) active Bit 7 = Remote bus active Bit 8 = Remote service port active Bit 9 = Pressure relief function active Bit 10 = Soft pressure function active Bit 11 = Low flow boost active Bit 12 = Low flow stop active Bit 13 = Proportional pressure active.

4.6 Data register block

Registers in this block can be read by means of function codes 0x03 and/or 0x04. They are read-only. The table below shows which registers each controller type supports.

Address	Register name	Scale	Hydro MPC	Hydro Multi-E
00301	Head	0.001 bar	S	S
00302	VolumeFlow	0.1 m^3/h	S	S
00303	RelativePerformance	0.01 %	●	●
00304 00305	RESERVED			
00306	DigitalInput	bits	●	●
00307	DigitalOutput	bits	●	●
00308	ActualSetpoint	0.01 %	●	●
00309	MotorCurrent	0.1 A	-	●
00310 00311	RESERVED			
00312 00313	PowerHI PowerLO	1 Watt	● ●	● ●
00314	RESERVED			
00315	InletPressure	0.001 bar	S	-
00316	RemotePressure	0.001 bar	S	-
00317	Level	0.01 m	S	S
00318 00319	RESERVED			
00320	RemoteTemp	0.01 K	S	S
00321 … 00324	RESERVED			
00325	AuxSensorInput	0.01 %	-	S
00326	RESERVED			
00327 00328	OperationTimeHI OperationTimeLO	1 hour	● ●	● ●
00329 00330	TotalPoweredTimeHI TotalPoweredTimeLO	1 hour	- -	● ●
00331	RESERVED			
00332 00333	EnergyHI EnergyLO	1 kWh	● ●	● ●
00334 … 00336	RESERVED			
00337	AmbientTemp	0.01 K	S	-
00338	InletTemp	0.01 K	S	-
00339	OutletTemp	0.01 K	S	-
00340	TempDifference	0.01 K	S	-
00341	OutletPressure	0.001 bar	S	-
00342	FeedTankLevel	0.01 m	S	-

S: Sensor required.

●: Always available.

A data value of 0xFFFF indicates "not available".
See section *8. Data item overview* for descriptions.

4.7 Subpump 1 register block

Address	Register name	Scale	Notes
00401	Bit 0: AccessMode	bool	Indicates if the subpump is locally or remotely controlled. 0 = Local (controlled by buttons on subpump) 1 = Remote (controlled by Hydro MPC). **Note:** This bit is only available when using Hydro MPC.
	Bit 1: OnOff	bool	Indicates if the subpump is on or off. 0 = Off 1 = On.
	Bit 2: Fault	bool	Indicates if a subpump has a fault or not. 0 = No fault 1 = Fault.
00402	AlarmCode	unscaled	The Grundfos-specific alarm code. See section *9. Grundfos alarm and warning codes*.
00403 00404	OperationTimeHI OperationTimeLO	1 h	The operating time of the subpump.
00405	Speed	0.01 %	The speed of the pump motor. **Note:** This bit is only available when using Hydro MPC.
00406 ... 00410	RESERVED		-

A register value of 0xFFFF indicates "not available".

4.8 Subpump 2 register block

Address	Register name	Scale	Notes
00411	Bit 0: AccessMode	bool	Indicates if the subpump is locally or remotely controlled. 0 = Local (controlled by buttons on subpump) 1 = Remote (controlled by Hydro MPC). **Note:** This bit is only available when using Hydro MPC.
	Bit 1: OnOff	bool	Indicates if the subpump is on or off. 0 = Off 1 = On.
	Bit 2: Fault	bool	Indicates if a subpump has an alarm or not. 0 = No fault 1 = Fault.
00412	AlarmCode	unscaled	The Grundfos-specific alarm code. See section *9. Grundfos alarm and warning codes*.
00413 00414	OperationTimeHI OperationTimeLO	1 h	The operating time of the subpump.
00415	Speed	0.01 %	The speed of the pump motor. **Note:** This bit is only available when using Hydro MPC.
00416 ... 00420	RESERVED		-

A register value of 0xFFFF indicates "not available".

4.9 Subpump 3 register block

Address	Register name	Scale	Notes
00421	Bit 0: AccessMode	bool	Indicates if the subpump is locally or remotely controlled. 0 = Local (controlled by buttons on subpump) 1 = Remote (controlled by Hydro MPC). **Note:** This bit is only available when using Hydro MPC.
	Bit 1: OnOff	bool	Indicates if the subpump is on or off. 0 = Off 1 = On.
	Bit 2: Fault	bool	Indicates if a subpump has an alarm or not. 0 = No fault 1 = Fault.
00422	AlarmCode	unscaled	The Grundfos-specific alarm code. See section *9. Grundfos alarm and warning codes*.
00423 00424	OperationTimeHI OperationTimeLO	1 h	The operating time of the subpump.
00425	Speed	0.01 %	The speed of the pump motor. **Note:** This bit is only available when using Hydro MPC.
00426 ... 00430	RESERVED		-

A register value of 0xFFFF indicates "not available".

4.10 Subpump 4 register block

Address	Register name	Scale	Notes
00431	Bit 0: AccessMode	bool	Indicates if the subpump is locally or remotely controlled. 0 = Local (controlled by buttons on subpump) 1 = Remote (controlled by Hydro MPC). **Note:** This bit is only available when using Hydro MPC.
	Bit 1: OnOff	bool	Indicates if the subpump is on or off. 0 = Off 1 = On.
	Bit 2: Fault	bool	Indicates if a subpump has an alarm or not. 0 = No fault 1 = Fault.
00432	AlarmCode	unscaled	The Grundfos-specific alarm code. See section *9. Grundfos alarm and warning codes*.
00433 00434	OperationTimeHI OperationTimeLO	1 h	The operating time of the subpump.
00435	Speed	0.01 %	The speed of the pump motor. **Note:** This bit is only available when using Hydro MPC.
00436 ... 00440	RESERVED		-

A register value of 0xFFFF indicates "not available".

4.11 Subpump 5 register block

Address	Register name	Scale	Notes
00441	Bit 0: AccessMode	bool	Indicates if the subpump is locally or remotely controlled. 0 = Local (controlled by buttons on subpump) 1 = Remote (controlled by Hydro MPC). **Note:** This bit is only available when using Hydro MPC.
	Bit 1: OnOff	bool	Indicates if the subpump is on or off. 0 = Off 1 = On.
	Bit 2: Fault	bool	Indicates if a subpump has an alarm or not. 0 = No fault 1 = Fault.
00442	AlarmCode	unscaled	The Grundfos-specific alarm code. See section *9. Grundfos alarm and warning codes*.
00443 00444	OperationTimeHI OperationTimeLO	1 h	The operating time of the subpump.
00445	Speed	0.01 %	The speed of the pump motor. **Note:** This bit is only available when using Hydro MPC.
00446 ... 00450	RESERVED		-

A register value of 0xFFFF indicates "not available".

4.12 Subpump 6 register block

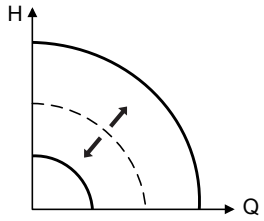
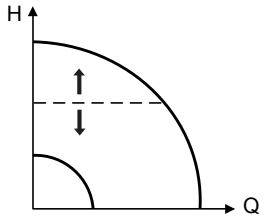
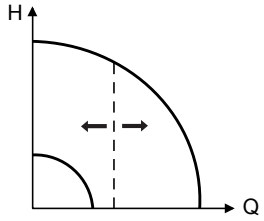
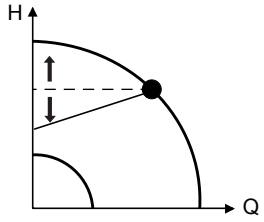
Address	Register name	Scale	Notes
00451	Bit 0: AccessMode	bool	Indicates if the subpump is locally or remotely controlled. 0 = Local (controlled by buttons on subpump) 1 = Remote (controlled by Hydro MPC). **Note:** This bit is only available when using Hydro MPC.
	Bit 1: OnOff	bool	Indicates if the subpump is on or off. 0 = Off 1 = On.
	Bit 2: Fault	bool	Indicates if a subpump has an alarm or not. 0 = No fault 1 = Fault.
00452	AlarmCode	unscaled	The Grundfos-specific alarm code. See section *9. Grundfos alarm and warning codes*.
00453 00454	OperationTimeHI OperationTimeLO	1 h	The operating time of the subpump.
00455	Speed	0.01 %	The speed of the pump motor. **Note:** This bit is only available when using Hydro MPC.
00456 ... 00460	RESERVED		-

A register value of 0xFFFF indicates "not available".

5. Detailed descriptions

5.1 Control modes

The supported control modes are described further in this section.

Control modes	Description	Illustration
> CONST_SPEED > CONST_FREQ	**Open loop** The setpoint of the controller will be interpreted as setpoint for the system performance. The setpoint value is a percentage of the maximum performance of the subpumps. No sensor is required in these modes.	 TM04 2289 2208
> CONST_HEAD > CONST_PRESSURE > CONST_DIFFPRESS	**Closed loop** The setpoint of the controller will be interpreted as setpoint for the pressure. The controller will adapt the speed of the subpumps so that the pressure is constant, regardless of the flow. A pressure sensor is required.	 TM04 2290 2208
> CONST_FLOW > CONST_TEMP > CONST_LEV	**Closed loop** The setpoint of the controller will be interpreted as setpoint for the flow, temperature or level. CONST_FLOW is indicated in the diagram. A relevant sensor is required: • A temperature sensor for temperature control, • a level sensor for level control and • a flow sensor for flow control.	 TM04 2288 2208
> VAR_DIFFPRESS	**Closed loop** The setpoint of the controller will be interpreted as setpoint in proportional pressure mode as shown in the diagram. A pressure sensor is required.	 TM04 2291 2208

H = Pressure (Head)

Q = Flow

5.2 Setpoint

This register accepts values ranging from 0 to 10000 (0 % to 100 %). This is illustrated in fig. 9. The setpoint is a percentage of the maximum setpoint or sensor maximum (max. = 100 %). The setpoint value can represent speed, pressure, flow, etc., depending on the selected control mode.

A setpoint of 0 does not imply a stop.

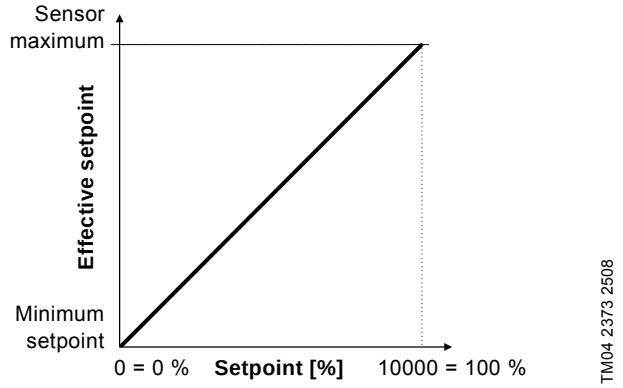


Fig. 9 Setpoint

5.2.1 Setpoint examples

Closed loop

If the control mode is set to CONST_PRESS (closed loop), and the pressure sensor is in the range of 0 to 10 bar, a setpoint of 80 % will result in an effective setpoint of 8 bar.

If the sensor range was 0-16 bar, a 50 % setpoint would be 8 bar, a 25 % setpoint would be 4 bar, and so on.

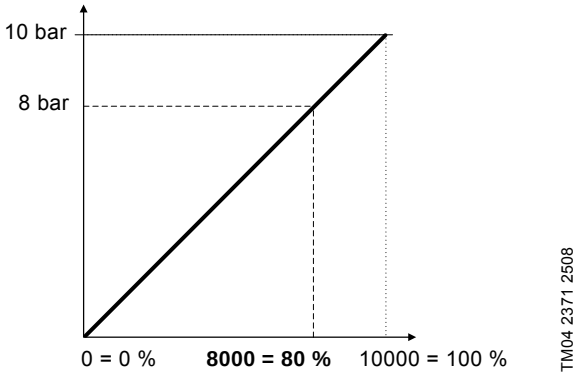


Fig. 10 Constant pressure

Open loop

If the control mode is set to CONST_FREQ (open loop), the setpoint is interpreted as setpoint for the system performance.

The example shows that a 50 % setpoint equals a 50 % system performance.

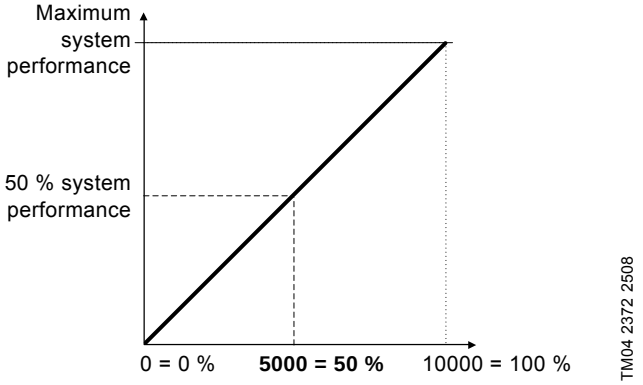


Fig. 11 Constant frequency

6. Commissioning

Note ***If the sensor configuration is changed, restart the CIU 200 to ensure a correct scaling of the sensor value.***

6.1 Step-by-step guide to hardware setup (CIU 200)

Step	Action
1	Complete the system configuration (for instance sensor configuration). This can be done either via the Grundfos R100 remote control (Hydro Multi-E), Grundfos PC Tool E-products, or on the operating panel (Hydro MPC).
2	Select the Modbus slave address (1-247).
3	Select the transmission speed of the Modbus slave.
4	Select parity and stop bits of the Modbus slave (even-1 or none-2).
5	If necessary, set line termination.
6	Connect the GENIbus cable from the CIU 200 to the controller.
7	Connect the necessary cables from the CIU 200 to the Modbus network.
8	Connect the power supply cable to the CIU 200, and switch the unit on.
9	Confirm that the GENIbus LED is constantly green and that the Modbus LED is either off (if no master is actively polling the slave) or flashing green (indicating error-free communication).
The CIU 200 is now ready to be accessed via the Modbus network.	

7. Fault finding

Faults in a CIU 200 can be detected by observing the status of the two communication LEDs. See the table below.

7.1 LED status

Fault (LED status)	Possible cause	Remedy
1. Both LEDs (LED1 and LED2) remain off when the power supply is connected.	a) The CIU 200 is defective.	Replace the CIU 200.
2. The LED for internal communication (LED2) is flashing red.	a) No internal communication between the CIU 200 and Hydro MPC / Hydro Multi-E.	• Check the cable connection between Hydro MPC / Hydro Multi-E and the CIU 200. • Check that the individual conductors have been fitted correctly. • Check the power supply to Hydro MPC / Hydro Multi-E.
3. The LED for internal communication (LED2) is constantly red.	a) The CIU 200 does not support the Hydro MPC / Hydro Multi-E connected.	Contact the nearest Grundfos company.
4. The Modbus LED (LED1) is constantly red.	a) Fault in the CIM 200 Modbus configuration.	• Check the transmission speed (switches SW4 and SW5). If the switches are set to "software-defined", an invalid value may have been set via Modbus. Try one of the preselected transmission speeds, e.g. 19200 bits/s. • Check that the Modbus address (switches SW6 and SW7) has a valid value [1-247].
5. The Modbus LED (LED1) is flashing red.	a) Fault in the Modbus communication (fault in parity or cyclic redundancy check).	• Check the transmission speed (switches SW4 and SW5). See section *3.4 Setting the Modbus transmission speed*. • Check the parity setting (switch SW3). See section *3.5 Setting the parity*. • Check the cable connection between the CIM 200 and the Modbus network. • Check the termination resistor settings (switches SW1 and SW2). See section *3.7 Termination resistor*.

7.2 Modbus communication faults

Fault	Possible cause	Remedy
1. The slave does not respond to telegrams.	a) Configuration or wiring error.	• Ensure that the cable between the Modbus master and the Modbus slave is connected correctly. See section *3.2 CIM 200 Modbus module* for wiring recommendations. • Ensure that the slave address is configured correctly, and that the correct slave address is used in the Modbus master poll. See section *3.6 Modbus address selection* for slave address selection. • Ensure that the transmission speed and stop bit/parity settings are configured correctly in both master and slave. • Ensure that each end of the Modbus trunk cable is terminated, if necessary. See section *3.7 Termination resistor* for line termination of the Grundfos slave. • Ensure that the bus topology for a Modbus network is correct.
	b) The slave may be in listen-only mode.	• Either send a restart communications diagnostics command, or restart the product manually.
	c) If the holding register of address 00001 "SlaveMinimumReplyDelay" is set too high, the master may time out before receiving the response from the slave.	• Increase the timeout span in the master in order to communicate.
2. The slave responds with exception response 0x01: "Invalid function".	a) The master is trying to use an unsupported function in the CIU 200.	• See section *11.2 Function code overview* for supported function codes. Note that reading and writing coils are not supported, so only register functions and diagnostics will be valid.
3. The slave responds with exception response 0x02: "Invalid data address".	a) The master is trying to read or write an invalid data address. If a master tries to read register addresses that are not listed in the tables, the slave will respond with this exception response. Some masters may automatically try to read large blocks in one telegram, which will cause problems if some of the registers in the block are not supported. An example would be reading the CIM configuration and CIM status blocks in one telegram: this is not possible since there are unused addresses between the blocks.	• Avoid reading or writing invalid data addresses.
	b) The register address offset may have been changed from default.	• Read the holding register at address 00002 "Register Offset" to see if this value is different from 0. If so, write the value 0 to this address to make the slave return to the default used in this functional profile.
4. The slave returns data value 0xFFFF (65535).	a) The value is unavailable. A data value of 0xFFFF does not necessarily indicate an error condition. It means that the value is unavailable from the controller.	• See section *8. Data item overview* for available data.
	b) The controller is not configured to show the value or lacks a sensor to read the value.	• See section *4.6 Data register block* for data values that require a sensor.
5. The slave does not change Modbus transmission speed with register 0004.	a) Configuration error.	• Set the transmission speed switches to "Software-defined". (Otherwise, the value in register 0004 is ignored by the slave).
	b) An invalid value may be set in register 00004.	• See section *3.4 Setting the Modbus transmission speed* for invalid values, and set correct value in register 00004.

8. Data item overview

Explanation to abbreviations used for scaling

bits: The data item is bit-interpreted.

enum: The data item has a pre-defined enumeration.

unscaled: The data item is unscaled (for instance a number, a counter, etc.).

Modbus address	Identifier	Scale	R/W	Description	Hydro MPC	Hydro Multi-E
CIM configuration register block						
00001	SlaveMinimumReplyDelay	ms	R/W	Minimum Modbus reply delay in ms.	●	●
00002	RegisterOffset	unscaled	R/W	Modbus address offset.	●	●
00004	ModbusBitRate	unscaled	R/W	Software-defined transmission speed.	●	●
00005	AutoAckControlBits	bool	R/W	Auto acknowledgement of control bits.	●	●
00009	SoftwareDefinedParity	enum	R/W	Parity setting in "software-defined" mode.	●	●
00010	SoftwareDefinedStopBit	enum	R/W	Stop bit setting in "software-defined" mode.	●	●
CIM status register block						
00021	GrundfosCRCErrorCnt	unscaled	R	Grundfos GENIbus CRC error counter.	●	●
00022	GrundfosDataErrorCnt	unscaled	R	Grundfos GENIbus data error counter.	●	●
00023	VersionNumber	unscaled	R	Version number.	●	●
00024	ActualModbusAddress	unscaled	R	Current Modbus slave address.	●	●
00025 00026	GrundfosTXcountHI GrundfosTXcountLO	unscaled	R	Grundfos GENIbus transmit counter.	●	●
00027 00028	GrundfosRXcountHI GrundfosRXcountLO	unscaled	R	Grundfos GENIbus receive counter.	●	●
00030	UnitFamily	unscaled	R	Grundfos product family.	●	●
00031	UnitType	unscaled	R	Grundfos product type.	●	●
00032	UnitVersion	unscaled	R	Grundfos product version.	●	●
Control register block						
00101	ControlRegister	bits	W	Control register.	●	●
00102	ControlMode	enum	W	Sets the control mode.	●	●
00103	OperationMode	enum	W	Sets the operating mode.	●	●
00104	Setpoint	0.01 %	W	Reference value (setpoint).	●	●
Status register block						
00201	StatusRegister	bits	R	Actual modes.	●	●
00202	ProcessFeedback	0.01 %	R	Actual process feedback value.	●	●
00203	ControlMode	enum	R	Readout of the actual control modes.	●	●
00204	OperationMode	enum	R	Readout of the actual operating mode.	●	●
00205	AlarmCode	enum	R	Actual alarm code.	●	●
00206	WarningCode	enum	R	Actual warning code.	●	-
00208	SubPumpsPresent	bits	R	Presence of subpumps.	●	●
00209	SubPumpsRunning	bits	R	Running status of subpumps.	●	●
00210	SubPumpsFault	bits	R	Fault status of subpumps.	●	●
00211	SubPumpsCommFault	bits	R	Communication status of subpumps.	●	●
00212	SystemActiveFunctions	bits	R	Active system functions.	●	-
Data register block						
00301	Head	0.001 bar	R	Actual system head/pressure.	S	S
00302	VolumeFlow	0.1 m^3/h	R	Actual system flow.	S	S
00303	RelativePerformance	0.01 %	R	Performance relative to maximum performance.	●	●
00306	DigitalInput	bits	R	Logical value of external digital input signals.	●	●
00307	DigitalOutput	bits	R	Logical value of external digital output signals.	●	●
00308	ActualSetpoint	0.01 %	R	Actual setpoint (according to control mode).	●	●
00309	MotorCurrent	0.1 A	R	Actual motor current.	-	●

Modbus address	Identifier	Scale	R/W	Description	Hydro MPC	Hydro Multi-E
00312 00313	PowerHI PowerLO	1 W	R	Total power consumption of the system.	●	●
00315	InletPressure	0.001 bar	R	System inlet pressure (relative to atmospheric pressure). Has an offset of -1.000 bar.	S	-
00316	RemotePressure	0.001 bar	R	Measured pressure at external sensor (relative to atmospheric pressure).	S	-
00317	Level	0.01 m	R	Tank level. Has an offset of -100.00 m.	S	S
00320	RemoteTemp	0.01 K	R	Temperature at external sensor.	S	S
00325	AuxSensorInput	0.01 %	R	Auxiliary sensor input.	-	S
00327 00328	OperationTimeHI OperationTimeLO	1 hour	R	Total operating time of the system.	●	●
00329 00330	TotalPoweredTimeHI TotalPoweredTimeLO	1 hour	R	Total power-on time of the system.	-	●
00332 00333	EnergyHI EnergyLO	1 kWh	R	Total energy consumption of the system.	●	●
00337	AmbientTemp	0.01 K	R	Ambient temperature.	S	-
00338	InletTemp	0.01 K	R	Inlet water temperature.	S	-
00339	OutletTemp	0.01 K	R	Outlet water temperature.	S	-
00340	TempDifference	0.01 K	R	Differential temperature.	S	-
00341	OutletPressure	0.001 bar	R	System outlet pressure.	S	-
00342	FeedTankLevel	0.01 m	R	Feed tank level. Has an offset of -100.00 m.	S	-
Subpump 1 register block						
00401	Subpump1Status	bits	R	Actual subpump status.	●	●
00402	AlarmCode	enum	R	Actual subpump fault code / alarm code.	●	●
00403 00404	OperationTimeHI OperationTimeLO	1 hour	R	Total operating time of the subpump.	●	●
00405	Speed	0.01 %	R	Speed of the subpump motor.	●	-
Subpump 2 register block						
00411	Subpump2Status	bits	R	Actual subpump status.	●	●
00412	AlarmCode	enum	R	Actual subpump fault code / alarm code.	●	●
00413 00414	OperationTimeHI OperationTimeLO	1 hour	R	Total operating time of the subpump.	●	●
00415	Speed	0.01 %	R	Speed of the subpump motor.	●	-
Subpump 3 register block						
00421	Subpump3Status	bits	R	Actual subpump status.	●	●
00422	AlarmCode	enum	R	Actual subpump fault code / alarm code.	●	●
00423 00424	OperationTimeHI OperationTimeLO	1 hour	R	Total operating time of the subpump.	●	●
00425	Speed	0.01 %	R	Speed of the subpump motor.	●	-
Subpump 4 register block						
00431	Subpump4Status	bits	R	Actual subpump status.	●	●
00432	AlarmCode	enum	R	Actual subpump fault code / alarm code.	●	●
00433 00434	OperationTimeHI OperationTimeLO	1 hour	R	Total operating time of the subpump.	●	●
00435	Speed	0.01 %	R	Speed of the subpump motor.	●	-
Subpump 5 register block						
00441	Subpump5Status	bits	R	Actual subpump status.	●	●
00442	AlarmCode	enum	R	Actual subpump fault code / alarm code.	●	●
00443 00444	OperationTimeHI OperationTimeLO	1 hour	R	Total operating time of the subpump.	●	●
00445	Speed	0.01 %	R	Speed of the subpump motor.	●	-

Modbus address	Identifier	Scale	R/W	Description	Hydro MPC	Hydro Multi-E
Subpump 6 register block						
00451	Subpump6Status	bits	R	Actual subpump status.	•	•
00452	AlarmCode	enum	R	Actual subpump fault code / alarm code.	•	•
00453 00454	OperationTimeHI OperationTimeLO	1 hour	R	Total operating time of the subpump.	•	•
00455	Speed	0.01 %	R	Speed of the subpump motor.	•	-

S: Sensor required.

• : Always available.

8.1 Temperature calculation

All temperatures are available in Kelvin.

Conversion formulas for Celsius and Fahrenheit:

$T_C = T_K - 273.15$

$T_F = T_K \times 9/5 - 459.67$

9. Grundfos alarm and warning codes

This is a general Grundfos alarm and warning code list. Not all codes are available in the controller.

Code	Description	Code	Description	Code	Description
1	Leakage current	35	Gas in pump head, deaerating problem	76	Internal communication fault
2	Missing phase	36	Discharge valve leakage	77	Communication fault, twin-head pump
3	External fault signal	37	Suction valve leakage	78	Fault, speed plug
4	Too many restarts	38	Vent valve defective	79	Functional fault, add-on module
5	Regenerative braking	40	Undervoltage	80	Hardware fault, type 2
6	Mains fault	41	Undervoltage transient	81	Verification error, data area (RAM)
7	Too many hardware shutdowns	42	Cut-in fault (dV/dt)	82	Verification error, code area (ROM, FLASH)
8	PWM switching frequency reduced	45	Voltage asymmetry	83	Verification error, FE parameter area (EEPROM)
9	Phase sequence reversal	48	Overload	84	Memory access error
10	Communication fault, pump	49	Overcurrent (i_line, i_dc, i_mo)	85	Verification error, BE parameter area (EEPROM)
11	Water-in-oil fault (motor oil)	50	Motor protection function, general shutdown (mpf)	88	Sensor fault
12	Time for service (general service information)	51	Blocked motor/pump	89	Signal fault, (feedback) sensor 1
13	Moisture alarm, analog	52	Motor slip high	90	Signal fault, speed sensor
14	Electronic DC-link protection activated (ERP)	53	Kipped motor	91	Signal fault, temperature 1 sensor
15	Communication fault, main system (SCADA)	54	Motor protection function, 3 sec. limit	92	Calibration fault, (feedback) sensor
16	Other	55	Motor current protection activated (MCP)	93	Signal fault, sensor 2
17	Performance requirement cannot be met	56	Underload	94	Limit exceeded, sensor 1
18	Commanded alarm standby (trip)	57	Dry running	95	Limit exceeded, sensor 2
19	Diaphragm break (dosing pump)	58	Low flow	96	Setpoint signal outside range
20	Insulation resistance low	59	No flow	97	Signal fault, setpoint input
21	Too many starts per hour	64	Overtemperature	98	Signal fault, input for setpoint influence
22	Moisture switch alarm, digital	65	Motor temperature 1 (t_m or t_mo or t_mo1)	99	Signal fault, input for analog setpoint
23	Smart trim gap alarm	66	Temperature, control electronics (t_e)	104	Software shutdown
24	Vibration	67	Temperature too high, internal frequency converter module (t_m)	105	Electronic rectifier protection activated (ERP)
25	Setup conflict	68	External temperature/ water temperature (t_w)	106	Electronic inverter protection activated (EIP)
26	Load continues even if the motor has been switched off	69	Thermal relay 1 in motor (e.g. Klixon)	110	Skew load, electrical asymmetry
27	External motor protector activated (e.g. MP 204)	70	Thermal relay 2 in motor (e.g. thermistor)	111	Current asymmetry
28	Battery low	71	Motor temperature 2 (Pt100, t_mo2)	112	Cos φ too high
29	Turbine operation (impellers forced backwards)	72	Hardware fault, type 1	113	Cos φ too low
30	Change bearings (specific service information)	73	Hardware shutdown (HSD)	120	Auxiliary winding fault (single-phase motors)
31	Change varistor(s) (specific service information)	74	Internal supply voltage too high	121	Auxiliary winding current too high (single-phase motors)
32	Overvoltage	75	Internal supply voltage too low	122	Auxiliary winding current too low (single-phase motors)

Code	Description	Code	Description	Code	Description
123	Start capacitor, low (single-phase motors)	183	Signal fault, extra temperature sensor	215	Soft pressure build-up timeout
124	Run capacitor, low (single-phase motors)	184	Signal fault, general-purpose sensor	216	Pilot pump alarm
144	Motor temperature 3 (Pt100, t_mo3)	185	Unknown sensor type	217	Alarm, general-purpose sensor high
145	Bearing temperature high (Pt100), in general or top bearing	186	Signal fault, power meter sensor	218	Alarm, general-purpose sensor low
146	Bearing temperature high (Pt100), middle bearing	187	Signal fault, energy meter	219	Pressure relief not adequate
147	Bearing temperature high (Pt100), bottom bearing	188	Signal fault, user-defined sensor	220	Fault, motor contactor feedback
148	Motor bearing temperature high (Pt100) in drive end (DE)	189	Signal fault, level sensor	221	Fault, mixer contactor feedback
149	Motor bearing temperature high (Pt100) in non-drive end (NDE)	190	Sensor limit 1 exceeded (e.g. alarm level in WW application)	222	Time for service, mixer
152	Communication fault, add-on module	191	Sensor limit 2 exceeded (e.g. high level in WW application)	223	Maximum number of mixer starts per hour exceeded
153	Fault, analog output	192	Sensor limit 3 exceeded (e.g. overflow level in WW application)	224	Pump fault (due to auxiliary component or general fault)
154	Communication fault, display	193	Sensor limit 4 exceeded	225	Communication fault, pump module
155	Inrush fault	194	Sensor limit 5 exceeded	226	Communication fault, I/O module
156	Communication fault, internal frequency converter module	195	Sensor limit 6 exceeded	227	Combi event
157	Real-time clock out of order	196	Operation with reduced efficiency	228	Not used
158	Hardware circuit measurement fault	197	Operation with reduced pressure	229	Not used
159	CIM fault (Communication Interface Module)	198	Operation with increased power consumption	230	Network alarm
160	GSM modem, SIM card fault	199	Process out of range (monitoring/ estimation/calculation/control)	231	Ethernet: No IP address from DHCP server
168	Signal fault, pressure sensor	200	Application alarm	232	Ethernet: Auto-disabled due to misuse
169	Signal fault, flow sensor	201	External sensor input high	233	Ethernet: IP address conflict
170	Signal fault, water-in-oil (WIO) sensor	202	External sensor input low	236	Pump 1 fault
171	Signal fault, moisture sensor	203	Alarm on all pumps	237	Pump 2 fault
172	Signal fault, atmospheric pressure sensor	204	Inconsistency between sensors	238	Pump 3 fault
173	Signal fault, rotor position sensor (Hall sensor)	205	Level float switch sequence inconsistency	239	Pump 4 fault
174	Signal fault, rotor origo sensor	206	Water shortage, level 1	240	Lubricate bearings (specific service information)
175	Signal fault, temperature 2 sensor (t_mo2)	207	Water leakage	241	Motor phase failure
176	Signal fault, temperature 3 sensor (t_mo3)	208	Cavitation	242	Automatic motor model recognition failed
177	Signal fault, Smart trim gap sensor	209	Non-return valve fault	243	Motor relay has been forced (manually operated/commanded)
178	Signal fault, vibration sensor	210	Overpressure	244	Fault, On/Off/Auto switch
179	Signal fault, bearing temperature sensor (Pt100), general or top bearing	211	Underpressure	245	Pump continuous runtime too long
180	Signal fault, bearing temperature sensor (Pt100), middle bearing	212	Diaphragm tank precharge pressure out of range	246	User-defined relay has been forced (manually operated/ commanded)
181	Signal fault, PTC sensor (short-circuited)	213	VFD not ready	247	Power-on notice (device/system has been switched off)
182	Signal fault, bearing temperature sensor (Pt100), bottom bearing	214	Water shortage, level 2	248	Fault, battery/UPS

10. Modbus address

Modbus address	SW 6	SW 7
1	0	1
2	0	2
3	0	3
4	0	4
5	0	5
6	0	6
7	0	7
8	0	8
9	0	9
10	0	A
11	0	B
12	0	C
13	0	D
14	0	E
15	0	F
16	1	0
17	1	1
18	1	2
19	1	3
20	1	4
21	1	5
22	1	6
23	1	7
24	1	8
25	1	9
26	1	A
27	1	B
28	1	C
29	1	D
30	1	E
31	1	F
32	2	0
33	2	1
34	2	2
35	2	3
36	2	4
37	2	5
38	2	6
39	2	7
40	2	8
41	2	9
42	2	A
43	2	B
44	2	C
45	2	D
46	2	E
47	2	F
48	3	0
49	3	1
50	3	2

Modbus address	SW 6	SW 7
51	3	3
52	3	4
53	3	5
54	3	6
55	3	7
56	3	8
57	3	9
58	3	A
59	3	B
60	3	C
61	3	D
62	3	E
63	3	F
64	4	0
65	4	1
66	4	2
67	4	3
68	4	4
69	4	5
70	4	6
71	4	7
72	4	8
73	4	9
74	4	A
75	4	B
76	4	C
77	4	D
78	4	E
79	4	F
80	5	0
81	5	1
82	5	2
83	5	3
84	5	4
85	5	5
86	5	6
87	5	7
88	5	8
89	5	9
90	5	A
91	5	B
92	5	C
93	5	D
94	5	E
95	5	F
96	6	0
97	6	1
98	6	2
99	6	3
100	6	4

Modbus address	SW 6	SW 7
101	6	5
102	6	6
103	6	7
104	6	8
105	6	9
106	6	A
107	6	B
108	6	C
109	6	D
110	6	E
111	6	F
112	7	0
113	7	1
114	7	2
115	7	3
116	7	4
117	7	5
118	7	6
119	7	7
120	7	8
121	7	9
122	7	A
123	7	B
124	7	C
125	7	D
126	7	E
127	7	F
128	8	0
129	8	1
130	8	2
131	8	3
132	8	4
133	8	5
134	8	6
135	8	7
136	8	8
137	8	9
138	8	A
139	8	B
140	8	C
141	8	D
142	8	E
143	8	F
144	9	0
145	9	1
146	9	2
147	9	3
148	9	4
149	9	5
150	9	6

Modbus address	SW 6	SW 7
151	9	7
152	9	8
153	9	9
154	9	A
155	9	B
156	9	C
157	9	D
158	9	E
159	9	F
160	A	0
161	A	1
162	A	2
163	A	3
164	A	4
165	A	5
166	A	6
167	A	7
168	A	8
169	A	9
170	A	A
171	A	B
172	A	C
173	A	D
174	A	E
175	B	F
176	B	0
177	B	1
178	B	2
179	B	3
180	B	4
181	B	5
182	B	6
183	B	7
184	B	8
185	B	9
186	B	A
187	B	B
188	B	C
189	B	D
190	B	E
191	B	F
192	C	0
193	C	1
194	C	2
195	C	3
196	C	4
197	C	5
198	C	6
199	C	7
200	C	8

Modbus address	SW 6	SW 7
201	C	9
202	C	A
203	C	B
204	C	C
205	C	D
206	C	E
207	C	F
208	D	0
209	D	1
210	D	2
211	D	3
212	D	4
213	D	5
214	D	6
215	D	7
216	D	8
217	D	9
218	D	A
219	D	B
220	D	C
221	D	D
222	D	E
223	D	F
224	E	0
225	E	1
226	E	2
227	E	3
228	E	4
229	E	5
230	E	6
231	E	7
232	E	8
233	E	9
234	E	A
235	E	B
236	E	C
237	E	D
238	E	E
239	E	F
240	F	0
241	F	1
242	F	2
243	F	3
244	F	4
245	F	5
246	F	6
247	F	7

Example: To set the slave address to the value 142, set the rotary switches SW6 and SW7 to "8" and "E", respectively.
Please note that 0 is not a valid slave address as this is used for broadcasting.

Caution ***It is very important to ensure that two devices do not have the same address on the network. If two devices have the same address, the result will be an abnormal behaviour of the whole serial bus.***

11. Modbus telegrams and function codes

11.1 Modbus telegram overview

The maximum size of a Modbus RTU telegram is 256 bytes. Telegrams must be separated by a silent interval of at least 3.5 character times.

The standard Modbus RTU telegram format is shown in the table below.

Slave address	Function code	Data	CRC
1 byte	1 byte	0 to 252 bytes	2 bytes

A telegram starts with the slave address occupying one byte. Then comes a variable-size data field. For each telegram, a CRC is calculated and appended to the telegram (two bytes total). All bytes in the telegram, except for the CRC itself, are included in the check.

Note ***The CRC bytes are not shown in the examples in the following sections.***

11.2 Function code overview

The table below shows a list of the supported function codes.

Type	Code	Hex	Name
16-bit data (registers)	03	0x03	Read holding registers
	04	0x04	Read input registers
	06	0x06	Write single register
	16	0x10	Write multiple registers
Diagnostics	08	08	Diagnostics See section *11.7 Diagnostics (0x08)* for subcodes.

Note ***Reading or writing coils are not supported.***

The same data are available in both holding registers and input registers, meaning that either function (0x03 or 0x04) can be used for reading data.

11.3 Read holding registers (0x03)

This function is used for reading holding registers from the slave.

The request telegram specifies the starting address (the address of the first register to be read) and the number of holding registers to read. In the telegram, register addresses start from zero, meaning that registers numbered 0-16 are addressed as 0-15.

The register data in the response message are packed two bytes per register. For each register, the first byte contains the high-order bits while the second byte contains the low-order bits.

Example of request from master to slave

Address	Function code	Start address HI	Start address LO	Quantity HI	Quantity LO
0x01	0x03	0x00	0x6B	0x00	0x03

In the request, the slave with address 1 is asked to deliver three contiguous registers starting from address 0x006b = 107 (meaning register 108).

Example of response from slave to master

Address	Function code	Byte count	Register 108 HI	Register 108 LO	Register 109 HI	Register 109 LO	Register 110 HI	Register 110 LO
0x01	0x03	0x06	0x00	0x01	0x00	0x01	0x00	0x01

In the response, the byte count is six since there are three registers of two bytes. All three registers hold the value of 0x0001.

11.4 Read input registers (0x04)

This function is used for reading input registers from the slave. Input registers are read-only registers by definition. The request telegram specifies the starting address (the address of the first register to be read) and the number of holding registers to read. In the telegram, register addresses start from zero, meaning that registers numbered 0-16 are addressed as 0-15.

The register data in the response message are packed two bytes per register. For each register, the first byte contains the high-order bits while the second byte contains the low-order bits.

Example of request from master to slave

Address	Function code	Start address HI	Start address LO	Quantity HI	Quantity LO
0x01	0x04	0x10	0x10	0x00	0x03

In the request, the slave with address 1 is asked to deliver three contiguous registers starting from address 0x1010 = 4112 (meaning register 4113).

Example of response from slave to master

Address	Function code	Byte count	Register 4113 HI	Register 4113 LO	Register 4114 HI	Register 4114 LO	Register 4115 HI	Register 4115 LO
0x01	0x04	0x06	0x22	0x22	0x22	0x22	0x22	0x22

In the response, the byte count is six since there are three registers of two bytes. All three registers hold the value of 0x2222.

11.5 Write single register (0x06)

This function is used for writing a single holding register in the slave. The request telegram specifies the address of the register that is to be written. Register addresses start from zero, meaning that a register numbered 10 is addressed as 9.

The normal response is an echo of the request, indicating that the value was written.

Example of request from master to slave

Address	Function code	Address HI	Address LO	Value HI	Value LO
0x01	0x06	0x10	0x00	0xAF	0xFE

In the request, the slave with address 1 is asked to write the value of 0xAFFE to the register at address 0x1000.

Example of response from slave to master

Address	Function code	Address HI	Address LO	Value HI	Value LO
0x01	0x06	0x10	0x00	0xAF	0xFE

The response is an echo of the request.

11.6 Write multiple registers (0x10)

This function is used for writing a block of contiguous holding registers in the slave. Register addresses start from zero, meaning that a register numbered 100 is addressed as 99.

Example of request from master to slave

Address	Function code	Start address HI	Start address LO	Quantity HI	Quantity LO	Byte count	Register 33 HI	Register 33 LO	Register 34 HI	Register 34 LO
0x01	0x10	0x00	0x20	0x00	0x02	0x04	0x00	0x01	0xB0	0xB0

In the request, the slave with address 1 is asked to write the value of 0x0001 to the register at address 0x0020 and the value of 0xB0B0 to the register at address 0x0021.

Example of response from slave to master

Address	Function code	Start address HI	Start address LO	Quantity written HI	Quantity written LO
0x01	0x10	0x00	0x20	0x00	0x02

The response returns the function code, starting address and quantity of registers written.

11.7 Diagnostics (0x08)

This function provides a test for checking the communication system between the master and the Grundfos slave. It contains a single-byte subcode to identify the test to be performed.

The following subcodes are supported:

Subcode	Name
0x00	Return query data Data in this request are to be echoed in the response. The response must be identical to the request, so this function is often used to verify Modbus communication.
0x01	Restart communications All communications counters are cleared, and the device is restarted.
0x02	Return diagnostics register Returns the 16-bit diagnostics register. See section *11.8 Diagnostics register interpretation*.
0x04	Force Listen Only Forces the device into listen-only mode. This effectively mutes the device, making it unable to communicate on the network. To bring the device back to normal mode, a "Restart communications" command (code 0x08, subcode 0x01) must be issued.
0x0A	Clear counters and diagnostics register Clears all counters and the diagnostics register. (These are also cleared on power-up/restart).
0x0B	Return bus message count Returns the number of messages detected by the slave.
0x0C	Return bus CRC error count Returns the number of CRC errors in the slave.
0x0D	Return bus exception count Returns the number of Modbus exception responses that the slave has transmitted.
0x0E	Return slave message count Returns the number of messages that the slave has processed.
0x0F	Return slave no response count Returns the number of messages for which the slave has sent no response.
0x12	Return bus character overrun count Returns the number of overruns in the slave.
0x14	Clear overrun counter Clears the overrun counter. (This is also cleared on power-up/restart).

Example of request from master to slave

Address	Function code	Subcode	Data	Data
0x01	0x08	0x00	0xAB	0xCD

The response is identical to the request.

Example of response from slave to master

Address	Function code	Subcode	Data	Data
0x01	0x08	0x00	0xAB	0xCD

11.8 Diagnostics register interpretation

The diagnostics register is interpreted as follows:

Bit	Description
0	Internal communication failure (with the Grundfos controller).
1	EEPROM self-test failed (the test is carried out when system is booted).
2	Grundfos controller not supported.
3	Modbus address offset is different from default value, i.e. it differs from 0.
4	Using software-defined Modbus transmission speed.
5	RESERVED
6	RESERVED
7	RESERVED
8	RESERVED
9	RESERVED
10	RESERVED
11	RESERVED
12	RESERVED
13	RESERVED
14	RESERVED
15	RESERVED

A bit value of 1 means true, unless otherwise specified. The diagnostics register is read using function code 0x08 and subcode 0x02.

12. Modbus telegram examples

Note ***CRC fields are not shown in the following examples.***

Note ***The Modbus data model states that registers numbered X are addressed in telegrams as X - 1, e.g. register 00104 (setpoint) is addressed as 00103 in a Modbus telegram.***

12.1 Diagnostics: return query data

This function is useful to ensure that the communication path and slave configuration are correct. It will echo the request in the response.

In the example, slave address 0x01 is used.

Request from master to slave

Field	Value	Description
Slave address	0x01	-
Function code	0x08	Diagnostics
Subcode	0x00	Echo request
Data	0xAB	Test data
Data	0xCD	Test data

Example of response from slave to master

Field	Value	Description
Slave address	0x01	-
Function code	0x08	Diagnostics
Subcode	0x00	Echo request
Data	0xAB	Test data
Data	0xCD	Test data

If there is no response from the slave, see section *7.2 Modbus communication faults*.

12.2 Reading CIM configuration register block

This shows how to read the CIM configuration register block (a total of 4 registers).

In the example, slave address 0x01 is used.

Request from master to slave

Field	Value	Description
Slave address	0x01	-
Function code	0x04	Read input registers
Start address HI	0x00	Start address = 0x0001
Start address LO	0x00	
Quantity HI	0x00	Number of registers = 0x0004
Quantity LO	0x04	

Example of response from slave to master

Field	Value	Description
Slave address	0x01	-
Function code	0x04	Read input registers
Byte count	0x08	8 bytes follow
00001 HI	0x0A	SlaveMinimumReplyDelay = 0x000A (10 ms)
00001 LO	0x00	
00002 HI	0x00	RegisterOffset = 0x0000 (no offset)
00002 LO	0x00	
00003 HI	0x00	Reserved value = 0x0000
00003 LO	0x00	
00004 HI	0x00	ModbusBitRate = 0x0004 (19200, software-defined)
00004 LO	0x04	

If there is no response from the slave, see section *7.2 Modbus communication faults*.

12.3 Setting the setpoint

This shows how to set a new setpoint (reference).

In the example, slave address 0x01 is used, and a value of 55 % (5500 = 0x157C) is set as new setpoint.

Request from master to slave

Field	Value	Description
Slave address	0x01	-
Function code	0x06	Write single register
Start address HI	0x00	Setpoint address = 00104 (0x0068)
Start address LO	0x67	
Value HI	0x15	New setpoint value = 5500 (0x157C)
Value LO	0x7C	

Example of response from slave to master

Field	Value	Description
Slave address	0x01	-
Function code	0x06	Write single register
Start address HI	0x00	Setpoint address = 00104 (0x0068)
Start address LO	0x67	
Value HI	0x15	New setpoint value = 5500 (0x157C)
Value LO	0x7C	

If there is no response from the slave, see section *7.2 Modbus communication faults*.

12.4 Setting the control mode

This shows how to set a control mode.

In the example, slave address 0x01 is used, and the control mode is set to 1 (CONST_FREQ).

Request from master to slave

Field	Value	Description
Slave address	0x01	-
Function code	0x06	Write single register
Start address HI	0x00	ControlMode address = 00102 (0x0066)
Start address LO	0x65	
Value HI	0x00	New ControlMode value = 1 (0x0001)
Value LO	0x01	

Example of response from slave to master

Field	Value	Description
Slave address	0x01	-
Function code	0x06	Write single register
Start address HI	0x00	ControlMode address = 00102 (0x0066)
Start address LO	0x65	
Value HI	0x00	New ControlMode value = 1 (0x0001)
Value LO	0x01	

If there is no response from the slave, see section *7.2 Modbus communication faults*.

12.5 Starting the controller

This shows how to start the controller.
In the example, slave address 0x01 is used.
Set the ControlRegister to the following values:

Bit 0:	1 (set the controller to remote mode)
Bit 1:	**1 (start the controller)**
Bit 2:	0 (do not send a reset fault command)
Bits 3-15:	0 (reserved values)

Hence the value to set is 0b0000000000000011 = 0x0003.

Request from master to slave

Field	Value	Description
Slave address	0x01	-
Function code	0x06	Write single register
Start address HI	0x00	ControlRegister address = 00101 (0x0065)
Start address LO	0x64	
Value HI	0x00	ControlRegister value = 3 (0x0003)
Value LO	0x03	

Example of response from slave to master

Field	Value	Description
Slave address	0x01	-
Function code	0x06	Write single register
Start address HI	0x00	ControlRegister address = 00101 (0x0065)
Start address LO	0x64	
Value HI	0x00	ControlRegister value = 3 (0x0003)
Value LO	0x03	

If there is no response from the slave, see section *7.2 Modbus communication faults*.

12.6 Stopping the controller

This shows how to stop the controller.
In the example, slave address 0x01 is used.
Set the ControlRegister to the following values:

Bit 0:	1 (set the controller to remote mode)
Bit 1:	**0 (stop the controller)**
Bit 2:	0 (do not send a reset fault command)
Bits 3-15:	0 (reserved values)

Hence the value to set is 0b0000000000000001 = 0x0001.

Request from master to slave

Field	Value	Description
Slave address	0x01	-
Function code	0x06	Write single register
Start address HI	0x00	ControlRegister address = 00101 (0x0065)
Start address LO	0x64	
Value HI	0x00	ControlRegister value = 1 (0x0001)
Value LO	0x01	

Example of response from slave to master

Field	Value	Description
Slave address	0x01	-
Function code	0x06	Write single register
Start address HI	0x00	ControlRegister address = 00101 (0x0065)
Start address LO	0x64	
Value HI	0x00	ControlRegister value = 1 (0x0001)
Value LO	0x01	

If there is no response from the slave, see section *7.2 Modbus communication faults*.

Argentina
Bombas GRUNDFOS de Argentina S.A.
Ruta Panamericana km. 37.500 Lote 34A
1619 - Garin
Pcia. de Buenos Aires
Phone: +54-3327 414 444
Telefax: +54-3327 411 111

Australia
GRUNDFOS Pumps Pty. Ltd.
P.O. Box 2040
Regency Park
South Australia 5942
Phone: +61-8-8461-4611
Telefax: +61-8-8340 0155

Austria
GRUNDFOS Pumpen Vertrieb Ges.m.b.H.
Grundfosstraße 2
A-5082 Grödig/Salzburg
Tel.: +43-6246-883-0
Telefax: +43-6246-883-30

Belgium
N.V. GRUNDFOS Bellux S.A.
Boomsesteenweg 81-83
B-2630 Aartselaar
Tél.: +32-3-870 7300
Télécopie: +32-3-870 7301

Belorussia
Представительство ГРУНДФОС в Минске
220123, Минск,
ул. В. Хоружей, 22, оф. 1105
Тел.: +(37517) 233 97 65,
Факс: +(37517) 233 97 69
E-mail: grundfos_minsk@mail.ru

Bosnia/Herzegovina
GRUNDFOS Sarajevo
Trg Heroja 16,
BiH-71000 Sarajevo
Phone: +387 33 713 290
Telefax: +387 33 659 079
e-mail: grundfos@bih.net.ba

Brazil
BOMBAS GRUNDFOS DO BRASIL
Av. Humberto de Alencar Castelo Branco, 630
CEP 09850 - 300
São Bernardo do Campo - SP
Phone: +55-11 4393 5533
Telefax: +55-11 4343 5015

Bulgaria
GRUNDFOS Pumpen Vertrieb
Representative Office - Bulgaria
Bulgaria, 1421 Sofia
Lozenetz District
105-107 Arsenalski blvd.
Phone: +359 2963 3820, 2963 5653
Telefax: +359 2963 1305

Canada
GRUNDFOS Canada Inc.
2941 Brighton Road
Oakville, Ontario
L6H 6C9
Phone: +1-905 829 9533
Telefax: +1-905 829 9512

China
GRUNDFOS Pumps (Shanghai) Co. Ltd.
51 Floor, Raffles City
No. 268 Xi Zang Road. (M)
Shanghai 200001
PRC
Phone: +86-021-612 252 22
Telefax: +86-021-612 253 33

Croatia
GRUNDFOS CROATIA d.o.o.
Cebini 37, Buzin
HR-10010 Zagreb
Phone: +385 1 6595 400
Telefax: +385 1 6595 499
www.grundfos.hr

Czech Republic
GRUNDFOS s.r.o.
Čajkovského 21
779 00 Olomouc
Phone: +420-585-716 111
Telefax: +420-585-716 299

Denmark
GRUNDFOS DK A/S
Martin Bachs Vej 3
DK-8850 Bjerringbro
Tlf.: +45-87 50 50 50
Telefax: +45-87 50 51 51
E-mail: info_GDK@grundfos.com
www.grundfos.com/DK

Estonia
GRUNDFOS Pumps Eesti OÜ
Peterburi tee 92G
11415 Talliinn
Tel: + 372 606 1690
Fax: + 372 606 1691

Finland
OY GRUNDFOS Pumput AB
Mestarintie 11
FIN-01730 Vantaa
Phone: +358-3066 5650
Telefax: +358-3066 56550

France
Pompes GRUNDFOS Distribution S.A.
Parc d'Activités de Chesnes
57, rue de Malacombe
F-38290 St. Quentin Fallavier (Lyon)
Tél.: +33-4 74 82 15 15
Télécopie: +33-4 74 94 10 51

Germany
GRUNDFOS GMBH
Schlüterstr. 33
40699 Erkrath
Tel.: +49-(0) 211 929 69-0
Telefax: +49-(0) 211 929 69-3799
e-mail: infoservice@grundfos.de
Service in Deutschland:
e-mail: kundendienst@grundfos.de

Greece
GRUNDFOS Hellas A.E.B.E.
20th km. Athinon-Markopoulou Av.
P.O. Box 71
GR-19002 Peania
Phone: +0030-210-66 83 400
Telefax: +0030-210-66 46 273

Hong Kong
GRUNDFOS Pumps (Hong Kong) Ltd.
Unit 1, Ground floor
Siu Wai Industrial Centre
29-33 Wing Hong Street &
68 King Lam Street, Cheung Sha Wan
Kowloon
Phone: +852-27861706 / 27861741
Telefax: +852-27858664

Hungary
GRUNDFOS Hungária Kft.
Park u. 8
H-2045 Törökbálint,
Phone: +36-23 511 110
Telefax: +36-23 511 111

India
GRUNDFOS Pumps India Private Limited
118 Old Mahabalipuram Road
Thoraipakkam
Chennai 600 096
Phone: +91-44 2496 6800

Indonesia
PT GRUNDFOS Pompa
Jl. Rawa Sumur III, Blok III / CC-1
Kawasan Industri, Pulogadung
Jakarta 13930
Phone: +62-21-460 6909
Telefax: +62-21-460 6910 / 460 6901

Ireland
GRUNDFOS (Ireland) Ltd.
Unit A, Merrywell Business Park
Ballymount Road Lower
Dublin 12
Phone: +353-1-4089 800
Telefax: +353-1-4089 830

Italy
GRUNDFOS Pompe Italia S.r.l.
Via Gran Sasso 4
I-20060 Truccazzano (Milano)
Tel.: +39-02-95838112
Telefax: +39-02-95309290 / 95838461

Japan
GRUNDFOS Pumps K.K.
Gotanda Metalion Bldg., 5F,
5-21-15, Higashi-gotanda
Shiagawa-ku, Tokyo
141-0022 Japan
Phone: +81 35 448 1391
Telefax: +81 35 448 9619

Korea
GRUNDFOS Pumps Korea Ltd.
6th Floor, Aju Building 679-5
Yeoksam-dong, Kangnam-ku, 135-916
Seoul, Korea
Phone: +82-2-5317 600
Telefax: +82-2-5633 725

Latvia
SIA GRUNDFOS Pumps Latvia
Deglava biznesa centrs
Augusta Deglava ielā 60, LV-1035, Rīga,
Tālr.: + 371 714 9640, 7 149 641
Fakss: + 371 914 9646

Lithuania
GRUNDFOS Pumps UAB
Smolensko g. 6
LT-03201 Vilnius
Tel: + 370 52 395 430
Fax: + 370 52 395 431

Malaysia
GRUNDFOS Pumps Sdn. Bhd.
7 Jalan Peguam U1/25
Glenmarie Industrial Park
40150 Shah Alam
Selangor
Phone: +60-3-5569 2922
Telefax: +60-3-5569 2866

México
Bombas GRUNDFOS de México S.A. de C.V.
Boulevard TLC No. 15
Parque Industrial Stiva Aeropuerto
Apodaca, N.L. 66600
Phone: +52-81-8144 4000
Telefax: +52-81-8144 4010

Netherlands
GRUNDFOS Netherlands
Veluwezoom 35
1326 AE Almere
Postbus 22015
1302 CA ALMERE
Tel.: +31-88-478 6336
Telefax: +31-88-478 6332
e-mail: info_gnl@grundfos.com

New Zealand
GRUNDFOS Pumps NZ Ltd.
17 Beatrice Tinsley Crescent
North Harbour Industrial Estate
Albany, Auckland
Phone: +64-9-415 3240
Telefax: +64-9-415 3250

Norway
GRUNDFOS Pumper A/S
Strømsveien 344
Postboks 235, Leirdal
N-1011 Oslo
Tlf.: +47-22 90 47 00
Telefax: +47-22 32 21 50

Poland
GRUNDFOS Pompy Sp. z o.o.
ul. Klonowa 23
Baranowo k. Poznania
PL-62-081 Przeźmierowo
Tel: (+48-61) 650 13 00
Fax: (+48-61) 650 13 50

Portugal
Bombas GRUNDFOS Portugal, S.A.
Rua Calvet de Magalhães, 241
Apartado 1079
P-2770-153 Paço de Arcos
Tel.: +351-21-440 76 00
Telefax: +351-21-440 76 90

România
GRUNDFOS Pompe România SRL
Bd. Biruintei, nr 103
Pantelimon county Ilfov
Phone: +40 21 200 4100
Telefax: +40 21 200 4101
E-mail: romania@grundfos.ro

Russia
ООО Грундфос
Россия, 109544 Москва, ул. Школьная 39
Тел. (+7) 495 737 30 00, 564 88 00
Факс (+7) 495 737 75 36, 564 88 11
E-mail
grundfos.moscow@grundfos.com

Serbia
GRUNDFOS Predstavništvo Beograd
Dr. Milutina Ivkovića 2a/29
YU-11000 Beograd
Phone: +381 11 26 47 877 / 11 26 47 496
Telefax: +381 11 26 48 340

Singapore
GRUNDFOS (Singapore) Pte. Ltd.
24 Tuas West Road
Jurong Town
Singapore 638381
Phone: +65-6865 1222
Telefax: +65-6861 8402

Slovenia
GRUNDFOS d.o.o.
Šlandrova 8b, SI-1231 Ljubljana-Črnuče
Phone: +386 1 568 0610
Telefax: +386 1 568 0619
E-mail: slovenia@grundfos.si

South Africa
Corner Mountjoy and George Allen Roads
Wilbart Ext. 2
Bedfordview 2008
Phone: (+27) 11 579 4800
Fax: (+27) 11 455 6066
E-mail: lsmart@grundfos.com

Spain
Bombas GRUNDFOS España S.A.
Camino de la Fuentecilla, s/n
E-28110 Algete (Madrid)
Tel.: +34-91-848 8800
Telefax: +34-91-628 0465

Sweden
GRUNDFOS AB
Box 333 (Lunnagårdsgatan 6)
431 24 Mölndal
Tel.: +46(0)771-32 23 00
Telefax: +46(0)31-331 94 60

Switzerland
GRUNDFOS Pumpen AG
Bruggacherstrasse 10
CH-8117 Fällanden/ZH
Tel.: +41-1-806 8111
Telefax: +41-1-806 8115

Taiwan
GRUNDFOS Pumps (Taiwan) Ltd.
7 Floor, 219 Min-Chuan Road
Taichung, Taiwan, R.O.C.
Phone: +886-4-2305 0868
Telefax: +886-4-2305 0878

Thailand
GRUNDFOS (Thailand) Ltd.
92 Chaloem Phrakiat Rama 9 Road,
Dokmai, Pravej, Bangkok 10250
Phone: +66-2-725 8999
Telefax: +66-2-725 8998

Turkey
GRUNDFOS POMPA San. ve Tic. Ltd. Sti.
Gebze Organize Sanayi Bölgesi
Ihsan dede Caddesi,
2. yol 200. Sokak No. 204
41490 Gebze/ Kocaeli
Phone: +90 - 262-679 7979
Telefax: +90 - 262-679 7905
E-mail: satis@grundfos.com

Ukraine
ТОВ ГРУНДФОС УКРАЇНА
01010 Київ, Вул. Московська 8б,
Тел.:(+38 044) 390 40 50
Фах.: (+38 044) 390 40 59
E-mail: ukraine@grundfos.com

United Arab Emirates
GRUNDFOS Gulf Distribution
P.O. Box 16768
Jebel Ali Free Zone
Dubai
Phone: +971-4- 8815 166
Telefax: +971-4-8815 136

United Kingdom
GRUNDFOS Pumps Ltd.
Grovebury Road
Leighton Buzzard/Beds. LU7 8TL
Phone: +44-1525-850000
Telefax: +44-1525-850011

U.S.A.
GRUNDFOS Pumps Corporation
17100 West 118th Terrace
Olathe, Kansas 66061
Phone: +1-913-227-3400
Telefax: +1-913-227-3500

Usbekistan
Представительство ГРУНДФОС в Ташкенте
700000 Ташкент ул.Усмана Носира 1-й тупик 5
Телефон: (3712) 55-68-15
Факс: (3712) 53-36-35

Addresses revised 20.05.2010

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Repl. 96846342 0809	

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